Appendix L

Adoption Task 1: Articulate the Vision for Science Education in Arkansas

Adoption Task 1 asks participants five key questions to help them develop the vision for what the NGSS will accomplish for students in our state. This vision is the cornerstone of the case for recommending adoption of the NGSS in Arkansas. A collective summary of the responses by grade band follows each of the five key adoption questions.

1. Are the NGSS essential to our success? Why or why not?

Forty participants responded of which 88 percent answered 'Yes' and twelve percent answered 'No' or 'I don't know' to this question.

Grades K–2:

> It is our biggest hope to create a scientifically literate society. The NGSS are based on the cognitive levels of students and provides a progression of learning throughout K–12. Additionally, the NGSS provide a coherent view of science by connecting scientific ideas across the disciplines. Finally, the standards incorporate a more realistic view of the work of scientists and engineers through a focus on science and engineering practices. The connection of the three foundation boxes (science and engineering practices, disciplinary core ideas, and crosscutting concepts) provides a framework for teaching and learning that builds coherency. The incorporation of engineering design provides opportunities for our students to engage in authentic real world problem solving that has been lacking in our current science standards. Engaging students in science in this way should enhance the economic development of our state and country.

Grades 3–5:

> Yes. The NGSS are essential to our success. After looking at our NAEP scores and seeing how few Arkansas graduates are going into STEM fields, it is imperative that we adopt standards that will connect science across grade levels, disciplines, and to real life applications. If we do not, we cannot expect test scores to increase or for students to be prepared to live in the real world.
>
> Although current Arkansas standards for science education have been rated as effective by some external studies, they do not include engineering in the K–12 years. Adoption of the NGSS could address this deficit.
>
> The inclusion of science and engineering practices into science standards greatly increases the hands–on nature of science education. This is vital to moving science from a collection of facts to a way of thinking for the citizens of our nation in the 21st century.

Grades 6–8:

Yes. Adopting the NGSS would be a step towards the vision. There are probably other options, however the NGSS are written well and have the vision in mind. Using them would make the process of revising *Arkansas Science Curriculum Frameworks* much easier.

The NGSS certainly puts educators and students on the right track for the successful education of our students. The NGSS not only raise the bar intellectually for students but challenge them to be critical thinkers, problem solvers, and skilled debaters—all of which could make them better global citizens.

Grades 9–12:

Yes. The NGSS are essential for the success of our students and our teachers. The NGSS are definitely important to improving our current standards and academic expectations. Any attempt to increase rigor and address our current inadequacies in college and career readiness and STEM career readiness could help us succeed, whether it is the NGSS or another document. The NGSS could help move our students in the right direction and improve Arkansas science education. The NGSS certainly put educators and students on the right track for the successful education of our students. The NGSS not only raise the bar intellectually for students but challenge them to be critical thinkers, problem solvers, and skilled debaters—all of which could make them better global citizens.

No. The NGSS are a fantastic set of content standards but are not necessarily essential to our success. The NGSS are just another blueprint that is a vision that might get us to a perceived goal.

The NGSS may be a great idea whose time have not yet come in Arkansas. A strong set of standards that hold students and teachers accountable for learning is essential. Without clear, attainable standards, teachers and students will do whatever they choose and feel most comfortable with. Our current *Arkansas Science Curriculum Frameworks* may be perfectly fine. If we revise Arkansas's science content standards, we would need to incorporate the engineering aspects and strengthen the technology component.

2. Will the NGSS fit into the overall STEM agenda for our state? Explain your answer.

Thirty-seven participants responded and 100 percent answered 'Yes' to this question.

Grades K–2:

With the emphasis on real world problems and interconnections between process, knowledge, and concepts, the NGSS follow the vision of the STEM Works agenda. The agenda is to enrich all areas of STEM education throughout Arkansas and to prepare students for new jobs. The NGSS lay out requirements and foster problem solving and critical thinking skills necessary to work collaboratively with peers. The NGSS put in the forefront science and engineering practices appropriate for the goals of STEM. EAST, Project Lead the Way, and New Tech schools all place heavy emphasis on real world problem solving and preparing our students for STEM–related careers.

Grades 3–5:

The NGSS fit very well with the STEM agenda. The NGSS would actually enhance and build the STEM initiative. If NGSS are adopted, science, engineering and technology education could be placed on an even playing field with literacy and mathematics education.

Grades 6–8:

Yes. With the STEM Works initiative, the NGSS align to the plan to prepare students in Arkansas in foundational and 21st century skills for college and/or career in STEM. It is a positive goal to "grow our own," to educate and prepare students to work, live, and succeed in STEM jobs here in Arkansas. This is what the STEM workforce is demanding of Arkansas educators.

Grades 9–12:

Without achieving this vision for science education through implementation of the NGSS, Arkansas will not have scientifically competent citizens or increase the number of students entering the STEM fields. These goals are critical if the state wants to attract business and increase the standard of living for its citizens. We have a problem filling positions in STEM jobs, especially "lower end" STEM jobs. Our students could be able to compete for these STEM jobs (lower and higher–end), if we increase the scientific competence of ALL students. Additionally, more tech–based businesses and manufacturing industries could be attracted to Arkansas if we train a ready and able work force.

3. What are we trying to accomplish for our students? Why is this important?

Forty-four participants responded to this question.

Grades K–2:

In science education, the goal is to foster students' natural curiosity about the world around them; to create in them a love and enthusiasm for science through problem solving, hands on investigations, and questioning; to develop their communication and collaborative skills; to develop risk takers who are masters of their learning; and to help students to see the connection across content areas.

We are trying to cultivate an early interest in science because we need to create a more scientifically literate society. Elementary grades need to cultivate that early interest in science so that this may continue in the upper grades. Research shows that an early interest in science is a major indicator of students who will eventually enter STEM–related careers. Something happens between elementary school and middle school where students lose their enthusiasm for science. If students are provided an environment that engages them and builds an excitement for learning about their world, then students might enter high school with an enthusiasm for learning, especially learning science.

Grades 3–5:

We need to improve science literacy for all students. Important local and global issues increasingly require a working scientific knowledge. Students need to be able to evaluate and interpret data, adequately evaluate claims, and form an appreciation for science and engineering. We are trying to provide activities and opportunities for our students that will provide them with the tools to help them become productive members of society, as well as the workforce. It is crucial in the 21st century and beyond that citizens are able to locate, evaluate, and use scientific and engineering information and skills to participate effectively in personal and community decisions.

Providing activities and opportunities that appeal to all learners is important because it better prepares our students for the grades ahead and eventually will better prepare them to excel in a world that is rapidly changing and advancing. Our students will enter various fields and should be exposed to content that is clear, concise, and relevant.

Grades 6–8:

We as science educators are trying to lay a foundation and should be developing students that by the end of their high school career are able to define problems, solve problems, work as individuals within a collaborative group, communicate, and logically design solutions. This is important because we are moving into an era when jobs require more and more critical thinking and problem solving skills.

Grades 9–12:

Science education is trying to create educated citizens that understand the world around them; provide students with a foundational science education for continuing their education in STEM careers; create employees with the skills and

knowledge needed to enter the STEM careers; provide opportunities for all students to learn and do science; provide opportunities for all students to be actively engaged in engineering, enhancing their critical thinking and problem solving skills; create an interest in our students to pursue careers in science and engineering fields; and provide our students with the knowledge of the endless career possibilities in the field of science and engineering.

This is important so that we produce critical thinkers and productive citizens in today's society that can fill jobs in STEM career fields. Graduating well–rounded students adept at problem solving and critical thinking is increasingly important in a world that emphasizes technology and engineering. Well–equipped students should be able to excel in the global market and be able to face and solve the growing economic, environmental, and medical challenges of tomorrow.

4. How will we know the vision has been achieved?

Forty participants responded to this question.

Grades K–2:

We will know the vision has been achieved in the short term when the quality and quantity of science instruction in the elementary grades improves. Is it being taught and is it being taught well? In addition, active engagement of students in their classes should be evident. Students will exhibit an enthusiasm for science. We will know this by watching trends in enrollment in science coursework at the upper levels as well as tracking trends in STEM careers. This information can also be tracked through TIMMS and NAEP data. We will also see proficiency levels increase on science content end–of–course testing both at the state and national levels. In the long term, we will know the vision has been achieved when the number of students who choose to enroll in upper level science classes such as advanced placement courses increases, the number of students who pursue a STEM–related degrees or certificates after high school graduation increases, and the fulfillment of STEM–related jobs by Arkansas graduates increases.

Grades 3–5:

We will first know the vision has been achieved when we start to see the effects of the implementation. Students will begin to think more critically about the world and this will be evident in their classroom interactions as well as students' academic performance. Due to the focus on actively engaging ALL students, there should be an increase in student interest in the sciences and this will increase in the number of students majoring in science careers at the university level. Another indicator that the vision has been achieved will be when students leave the education sector and enter the workforce with the skills and knowledge needed for jobs worldwide. This will be determined when the U.S. is exporting more skilled labor to other countries, along with our technology, than we import

today. A third indicator will be when people who have come through the U.S. education system are filling the better jobs, that are increasingly be filled by people from other countries.

Grades 6–8:

We will know when the vision has been achieved when our students emerge from high school with the skills necessary to go into the work force or continue in higher education with little or no remediation. We should also see more students achieving higher educational training in the technical areas leading to an increase in the number of professional positions filled by our graduates. We will be aware of how we are achieving our vision through data collected from assessments and through the number of students entering science related careers or completing college degrees in a science related fields.

Grades 9–12:

Nationally, we should see NAEP scores rise. At the state level, we should see a rise in ACT scores in the science area. We should see a statistical difference in the number of students entering STEM fields in college. Placing more students in STEM fields is especially critical for “lower end” STEM careers. If STEM jobs are thought of on a continuum from “lower end” (e.g., hospital technicians, car mechanics) to “higher end” (e.g., university researchers, pharmacists, doctors), we need to focus more on the “lower end” STEM jobs. For example, a car mechanic is no longer a person who turns wrenches; a car mechanic must be able to troubleshoot and program computers.

5. Describe what is keeping us from achieving the vision.

Thirty-seven participants responded to this question.

Grades K–2:

Many things are keeping us from reaching this vision and it starts in the early grades. The lack of accountability in science is keeping the vision from being met. Elementary teachers should teach science and this is not happening consistently in many Arkansas schools, resulting in a large leak in the STEM pipeline. Teachers are not being held accountable by school administrators, and school administrators are not being held accountable by the state department and policy makers to provide an adequate amount of the time to science instruction in elementary grades. Students are not provided with opportunities to experience real world problem solving, science investigations, and collaboration with peers to develop their talents in STEM. Research indicates it is in the early grades when students explore their talents and develop an area of interest. If they are not exposed to science until the later grades, they may not realize this area of talent.

In addition, the fact that many elementary teachers lack the content knowledge to teach science and have a fear of teaching science is keeping us form achieving the vision. Many teachers in Arkansas lack a deep knowledge of science content, skills, and pedagogy.

Grades 3–5:

At the elementary level, the prevailing attitude among administrators that science is not important is keeping us from achieving the vision. In addition, most districts have only a district level math specialist and a district level literacy specialist. Since there are few district level science specialists, science is pushed out of instruction. The other problem that keeps us from this vision is that many elementary teachers have an inadequate pre–service experience that results in a limited knowledge of science content and inquiry. Taking one or two science classes in college is not adequate for understanding the complex science concepts students in elementary are required to know. In addition, teachers teach the way they are taught. If we are engaging elementary students in hands–on, higher–order thinking and learning experiences, college instruction needs to model this.

A lack of funding is also a major factor preventing full achievement of the vision. Few schools have the resources to supply the needed instructional materials and to hire effectively trained science educators.

Lack of communication is another big issue. For example, information is either misinterpreted or it is not passed on at all to teachers.

Finally, lack of student accountability in Grades K–4 is keeping us from achieving the vision. As a result, upper grade teachers are faced with the impossible task of filling huge gaps in science fluency while trying to address grade level requirements for the Grades 5 and 7 benchmark tests. The current system of assessments only requires students to guess and check.

Grades 6–8:

There are a number of items that are keeping us from achieving this vision. These include the narrow focus of testing on only literacy and mathematics, uneven resource allocation for all academic areas, lack of available professional development specific for in–service science teachers, and the lag in teacher education programs to align to the vision for science education.

In addition, time is a factor keeping us from achieving the vision. Time is needed for training; for preparation, planning, and collaboration; for classroom instruction without interruption; for parents to see the value in STEM education; and for Grades K–5 teachers to teach all of the science student learning expectations each year.

Grades 9–12:

There are several factors keeping us from achieving the vision: time constraints on classroom teachers; financial constraints on funding for necessary materials and technology; lack of in depth professional development that prepares teachers to develop the appropriate instructional strategies to achieve the vision; lack of knowledge and skills of teachers in the area of earth and space science and engineering; lack of teacher training, knowledge, and education in the elementary teaching programs of study; lack of in–depth training on how to use software necessary for the design and use of models and simulations; lack of student technology skills beyond their personal technology devices; and lack of emphasis within school districts on science due to the current emphasis on literacy and math.